Points to Note:

Wider bandwidths than were used on 140 Foot

Cleaner antenna so other effects show up

Larger antenna:  1. Reflections have longer paths
                2. Higher $T_a$ on continuum sources

Our tests intentionally provoked baseline distortions
Talk Outline

Baseline Distortion Points
  Antenna
  Receivers
  IF system
  Spectrometers
  RFI

Observing Strategies

Continuing Work
Total Power Observations

“ON” - “OFF”

\[ \frac{G_{\text{src}}(f) \times T_{\text{src}}(f)}{G_{\text{sys}}(f) \times T_{\text{sys}}(f)} \]
System Block Diagram

- **Rcvr Room**
  - Receiver
  - LO
  - IF Rack ODM

- **Fiber 1–8 GHz**
  - Optical Rcvr
  - Converter Module
  - Analog Filter Module
  - Spectrometer Sampler

- **Equipment Room**
  - LO
Antenna Noise Spectrum

- Background
- Atmosphere
- Spillover
(ON - OFF) / OFF Spectra (1.4 GHz)
Sub-reflector has been displaced for ON scan
Red: horizontal pol’n; Green: vertical pol’n
Periodogram of 1/8-wavelength Sub-reflector Displacement Spectra (1.4 GHz)
Red: horizontal pol’n, Green: vertical pol’n
21-cm Frequency Switched Spectrum (Ta/Tsys) (BW = 40 MHz; Delta-f = 1 MHz)
(ON – OFF)/OFF Spectra (5 Ghz)
Sub-reflector has been Displaced for ON scan
Red: horizontal pol’n, Green: vertical pol’n
Periodogram of 1/8-wavelength Sub-reflector Displacement Spectra (5 GHz)
Red: horizontal pol'n, Green: vertical pol'n
Periodogram of 1/8-wavelength sub-reflector displacement spectra (9 GHz, BW = 800 MHz)
Continuum Source Spectra
(ON – OFF)/OFF Continuum Source Spectra (1.99 GHz; Flux = 5.7 Jy)
Red: channel X, Green: channel Y
(ON – OFF)/OFF Continuum Source Spectra (1.99 GHz, Flux=5.7 Jy)
Red: channel X, Green: channel Y
Periodograms of Continuum Source Spectra (1.99 GHz, BW = 200 MHz)
Red: channel X, Green: channel Y
(ON – OFF)/OFF Source Continuum Spectra (1.4 GHz)

2316+0405 3.8 GHz Scan 318 9 levels

2 x 2.21 Jy
5.08 Jy
4.68 Jy
2 x 2.21 Jy
Composite Continuum Source Spectrum (1.4 GHz, Flux = 4.68 Jy)
Red: channel X, Green: channel Y

Frequency in MHz

2316+0405 3.8.1 Scan 18  9 levels

GBT Spectral Baselines – Tuesday, 11 March 2003
Continuum Source Spectrum (5 GHz, Flux = ~5 Jy)
Red: channel X, Green: channel Y
Noise Reflections within Feed/LNA System

-10 dB  -35 dB  -35 dB  -40 dB
Dewar

15K
OMT

300K
Gap

WG window

2K  1K  3K  1K

up to 3.3 meters

Feed

-50 dB

10K
Continuum Source Spectrum (8.8 GHz, Flux=3.4 Jy)
Waveguide Thermal Gap

Diagram showing the waveguide thermal gap with Dewar, feed, gap 300 K, gap 15 K, OMT, and LNAs.
Ku-band Receiver Total Noise Power
15.2 GHz (top left) to 11.7 GHz (bottom right)
Ku-band Receiver Total Noise Power (copper tape over gap)  
15.2 GHz (top left) to 11.7 GHz (bottom right)
Continuum Source Baseline Strategies

Reduce small-scale structure in receiver noise

Verify LNA/OMT/Feed noise structure (improve designs)

Calibrate with strong continuum sources
NGC7027 Continuum Spectra  (5 GHz, Flux = 5.4 Jy)
5-minute ON, 5-minute OFF
Red: channel X,  Green: channel Y
Ratios of NGC7027 Continuum Spectra (5GHz, Flux = 5.4 Jy)
11 Minute Intervals for 3 Hours
Note: spectra offset for illustration
Ratios of 3C48 to NGC7027 Continuum Spectra (5 GHz)
Red: channel X, Green: channel Y
Note: spectra offset for illustration
Ratio of Continuum Spectra of 1042+1203 between Beam Center and Roughly Half Power Points (1.4 GHz)
IF System
Total Power IF Spectrum Sample (3 GHz)
2.4 MHz Ripple Period in Optical Modulators
IF Spectrum Autocorrelation Function

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Frequency Dependence of Optical Modulator Gain Ripple Amplitude
Total Power IF Spectrum Sample of Modified Modulator (3 GHz)
IF Spectrum Autocorrelation Function
Red: original modulator,  Green: modified modulator
IF System Cable Connections

- Receiver (1.5, 3, or 6 GHz (~3.5 m))
- Optical Modulator
- Optical Fiber
- Optical Receiver (2.4 m)
- Convertor Module (0.8–1.6 GHz (7.1 m))
- Analog Filter Module (0.8–1.6 GHz (6.5 m))
- Spectrometer Sampler
IF Spectrum Difference of 30-second Records
5 Minutes Apart

![Graph of IF spectrum difference](image)

Frequency in MHz
Correlation of IF Ripple Amplitude with Temperature

- 62-MHz Ripple Amplitude
- Rack Air Temp.
- Room Temp.
IF Spectrum Difference due to 19mm Change in 6-GHz Cable Length between Optical Receiver and Converter Module (63 MHz Ripple)
Detected IF Ripple Periods for 8 IF Channels
Period = 800 MHz / FFT Channel
General Strategy

Stabilize 63 MHz ripple (phase-stable cables)

Re-measure (and fix) other IF spectrum ripple periods

Return to receiver stability measurements
Other Sources of Baseline Problems

Spectral Processor quantization (?)

RFI
(Tsys / Tcal) for Different Spectral Processor Input Levels (BW = 40 MHz)
Red: -5 dBm, Green: -12 dBm, Blue: -15 dBm
Other Sources of Baseline Problems

Spectral Processor quantization (?)

RFI
1.4 GHz, 10 MHz BW, Spectral Distortion Probably due to Wideband RFI or Receiver Overload due to RFI; ~ 40 seconds duration
20 GHz System Temperature
Note: Two Curves use Different IF and Spectrometer Channels
20 GHz Continuum Spectrum of 3C123, Receiver R2
Successive 5-minute ON-OFF Pairs
140 Foot Continuum Source Spectra (8.4 GHz, BW = 40 MHz)
6-minute ON, 6-minute OFF; Taken with the Spectral Processor
140 Foot Continuum Source Spectra (1.38 GHz, BW = 40 MHz)
6-minute ON, 6-minute OFF; Taken with the Spectral Processor